



GLAST Large Area Telescope Calorimeter Subsystem 5.2 Production of CsI Crystals

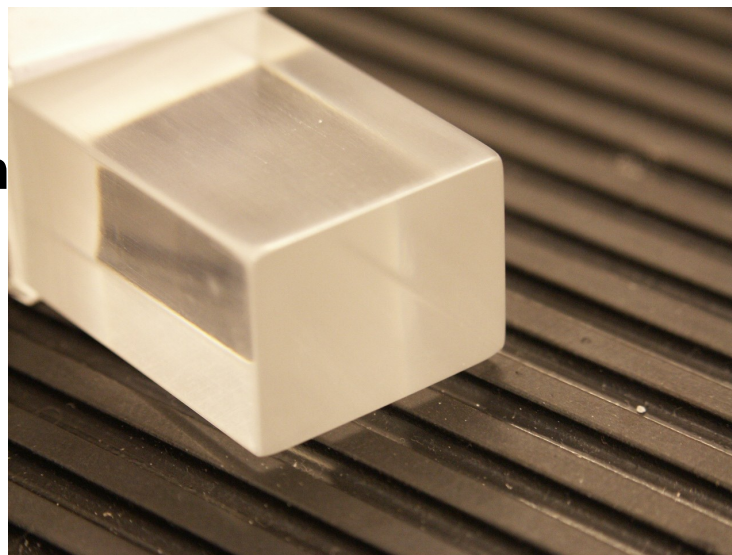
**Leif Nilsson
Swedish GLAST Consortium**

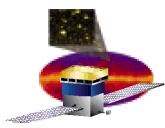
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Outline

- ❑ **Swedish GLAST Consortium**
- ❑ **Crystal Requirements**
- ❑ **Crystal Procurement Status**
- ❑ **Crystal Production Flow (Ukraine and Sweden)**
- ❑ **Production Tooling (Ukraine)**
- ❑ **Crystal Receiving Inspection (Sweden)**
- ❑ **Rad Tests of CsI Crystals**
- ❑ **Production Schedule**
- ❑ **Work Scheme / Staff Plan**
- ❑ **To Do List**
- ❑ **Summary**





Swedish GLAST Consortium

- ❑ **Responsibility from Stockholm University and The Royal Institute of Technology (KTH).** Lars Bergström, Roland Svensson and Per Carlson
- ❑ **Crystal production team at Kalmar University.** Staffan Carius, Leif Nilsson, Georg Johansson, Sara Bergenius and Tatjana Kirchberg
- ❑ **Boule sample testing at KTH.** Sara Bergenius, Staffan Carius, Georg Johansson and Mark Pearce



Per Carlson signing GLAST contract together with Vadim Lubinsky (Amcrys-H)



Crystal Requirements

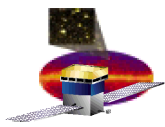
- ❑ **Statement of FM requirements in Performance Spec**
 - **LAT-DS-00820-03**
 - **Addresses mechanical and optical performance, shipping and handling, and quality control**

	Issue	Requirements / Comments
Mechanical	Dimensions and tolerance	Flatness of surfaces, parallelism of opposing surfaces, perpendicularity of adjacent surfaces
	Surface treatment	Polished surfaces with treatment for required light taper along crystal's length
Optical Performance	Light yield	Measured with Swedish provided test bench w/ Swedish test procedure.
	Light yield uniformity	All crystals must have same yield +/- 10%
	Light taper	End - to - end light collection requirement
	Radiation Hardness	Verified on boule samples prior to manufacture of crystals from the boule. Sweden does the test
Shipping and Handling	Shipping	Containers, environmental protection, tracking and data records
	Inspection and Tests	Acceptance testing, process control, quality provisions
Quality Control	Traceability	Amcrys-H process control and data records



Crystal Procurement Status

- ❑ **Contract and procurement process by Swedish Consortium**
 - **Competitive selection of vendor began Dec 2000**
 - **Final selection of Amcrys-H in Feb 2001**
 - **Final contract crystal spec (LAT-DS-00095-05) completed after negotiation with vendor**
 - **Prototype crystals delivered May 2001 - Apr 2002**
 - **244 EM xtals manufactured to LAT-DC-00095-05**
 - **Xtal dimensions (for EM and FM) modified Feb 2002**
 - **From review of tolerances of CAL components and build-up of tolerances**
 - **Xtals shortened by 7 mm (333 mm became 326 mm)**
 - **Chamfers enlarged and better defined**
 - **Revised specification Feb 2002**
 - **CAL Csl Crystal Performance Specification LAT-DS-00820-03**
 - **All EM xtals remachined at Amcrys and Kalmar to comply with new dimensions, Jun-Oct 2002**
 - **48 prototype xtals built to new spec arrived Kalmar Feb 2003**
- ❑ **Successful flight Procurement Readiness Review Feb 2003**
 - **First flight xtal delivery to Kalmar expected Apr 2003**
 - **Total flight purchase: 1945 xtals**



Crystal Production Flow (**Ukraine** and **Sweden**)

Boule growing - Making boule samples - (Rad testing in Sweden) - Machining crystal logs - Polish crystal - Verify mechanical dimensions, marking - Resting - Light tuning - Tyvek and alu-foil wrapping - Vacuum-packing - Shipping to Sweden (Kalmar) - Checking documents and storage - Mechanical and optical acceptance test - Vacuum-pack in CEA V-block - Distributing results (CEA, NRL) - Packing in CEA-container - Shipping to CEA via Gondrand

Pictures following pages.



Crystal Production Flow (1/5)

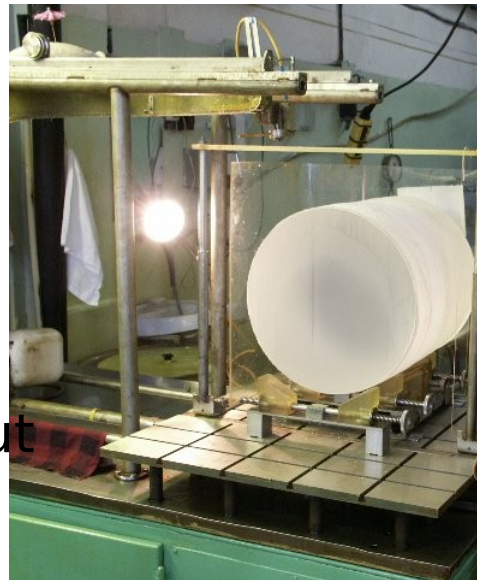


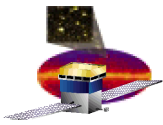


Crystal Production Flow (2/5)

Boule growing at AMCRYS-H
Boule production equipment
made by AMCRYS-H

CsI crystal
ready to be cut





Crystal Production Flow (3/5)

After verification at KTH, the boules are cut in slices and logs. After that the chamfers are made and the length are corrected.





Crystal Production Flow (4/5)

After polishing the crystal are accurately measured to ± 0.03 mm

**All these measurements are verified in Kalmar
Production statistics is collected**

Adjustment needs are fed back to



Longitudinal measurements





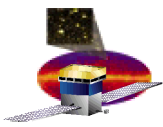
Crystal Production Flow (5/5)

Crystals are surface treated and optically tested 2 - 3 times



Dimitry
adjusts
light tapering.





Production Tooling (Ukraine)

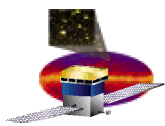
- ❑ Several production toolings have been improved by AMCRYS-H during procurement ti



Fixtures to stabilize measurements

New end face-grinding fixture





Crystal Receiving Inspection (Sweden)

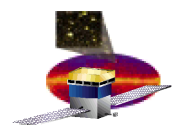
- ☐ Check shipment container for improper handling
- ☐ Open container and file documents, send boule samples to KTH in Stockholm
- ☐ (Store container and crystals)
- ☐ Open inner box
- ☐ Break vacuum sealing in semi-clean room
- ☐ Make visual, optical and mechanical inspection according to checklist and workorder
- ☐ Check data files and paper documents of specific crystal
- ☐ Classify crystal (Pass/Fail/Set aside)
- ☐ Vacuum-pack crystal in V-block from CEA

EM Crystal Visual and Dimensional Inspection Checklist

Item Description Engineering Model Csl Crystal	Part Number:	Serial Number:	Accepted <input type="checkbox"/>	Rejected <input type="checkbox"/>
Received From:	Quality Assurance Manager Name: Date:		Inspection Performed By Name: Date:	
Received Date:			Temp: R/H:	

	Yes	No	Reject	Remarks
VISUAL INSPECTION To be performed under 1 – 10X magnification. Mark anomalies on attached crystal drawing. Arrow scratch defines "top" and "right" xtal orientation. Long side faces are denoted "top fat", "front skinny", "bottom fat", and "back skinny."				
SHIPPING WRAPS AND SUPPORT <ul style="list-style-type: none">- Vacuum bagging- Tyvek and aluminum foil wrap material- Tyvek and aluminum foil end caps- Wrap sealed with Kapton tape- Aluminum supporting sleeve	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Opened time:
CRYSTAL SIZE <ul style="list-style-type: none">- Approximately 326 x 27 x 20 mm	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CRYSTAL ORIENTATION FIDUCIAL MARK <ul style="list-style-type: none">- "Arrow" scratch exists near one end of fat side	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
CRYSTAL CLARITY <ul style="list-style-type: none">- Clear- Clear – probably, but machining/Tyvek marks obscure view- Milky, cloudy	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	
CHAMFERS <ul style="list-style-type: none">- Chamfers present, approximately as per dwg- Sharp edges on chamfers	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	

Portion of EM
visual inspection
form

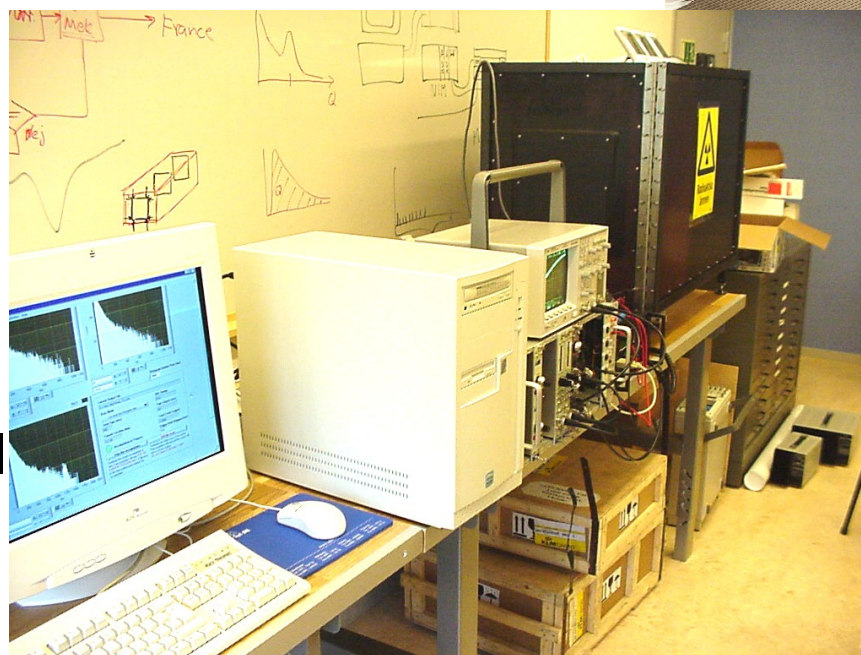


Crystal Inspection in Kalmar.

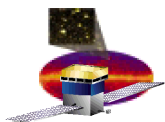
Optical and mechanical measurements at Kalmar University



Georg preparing one crystal for optical testing

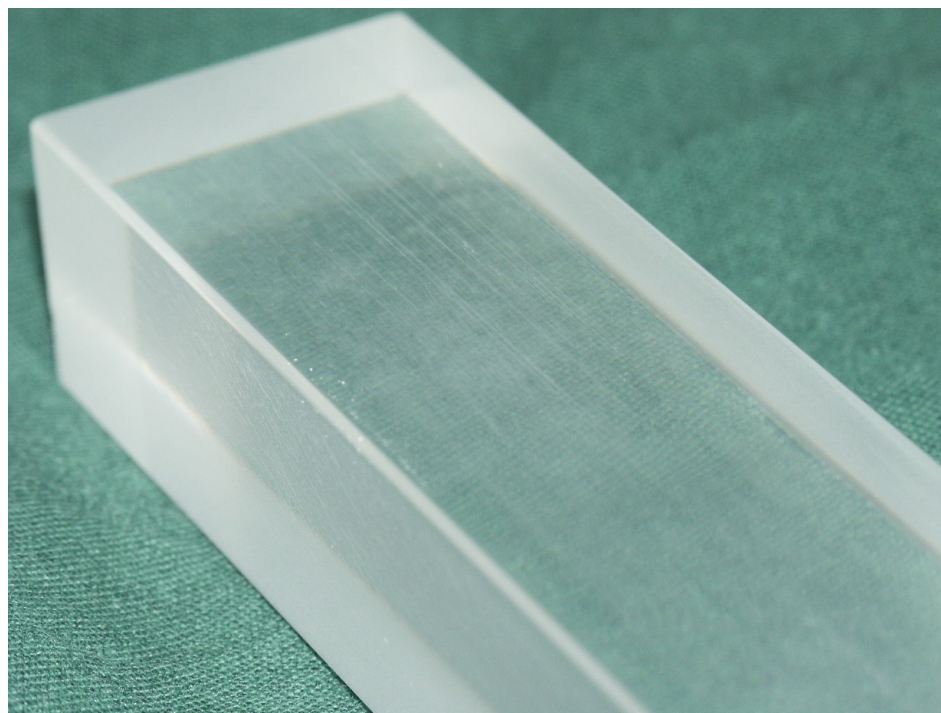


Optical test bench



EM Crystal Quality

EM xtals met revised mechanical and optical requirements (ref. 4.0 CAL Design and Development by Grove)





Rad Tests of CsI Crystals

^{60}Co gamma tests: 1 - 2 krad/h, ≤ 20 krad

boule samples (2.5cm x 2.5cm)

Report: preliminary test at KTH facility Summer 2002,

Amcrys material OK

Report: 1st test at the KI facility of 7 boule samples for production

Plan: to use the KI facility regularly for boule sample tests (2nd test 5 March 2003)

long crystal (full size)

Report: 1st test at KI facility, light yield 76% after 18 krad, 10% less than boule sample

Plan: 2nd test to establish accurate correspondence to boule sample

Proton beam test

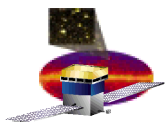
180 MeV scattered beam

spraying entire crystal transversely

2 krad/h up to 20 krad

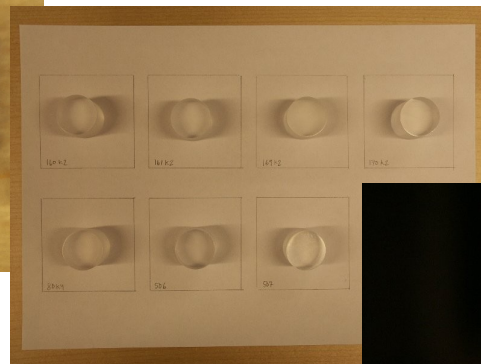
@Uppsala cyclotron 7, 8 April 2003

<u>boule</u>	<u>20 krad</u>
58k4	84%
70k4	67%
72k4	67%
73k4	81%
74k4	79%
75k4	75%
77k4	81%

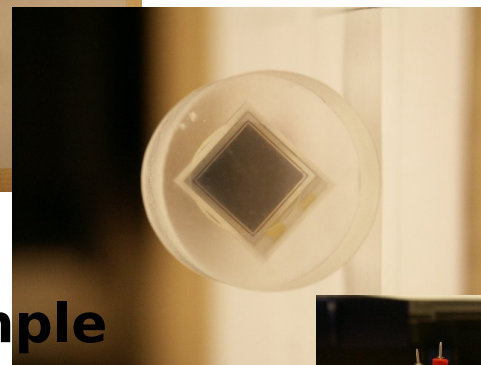


Rad Tests of Boule Samples

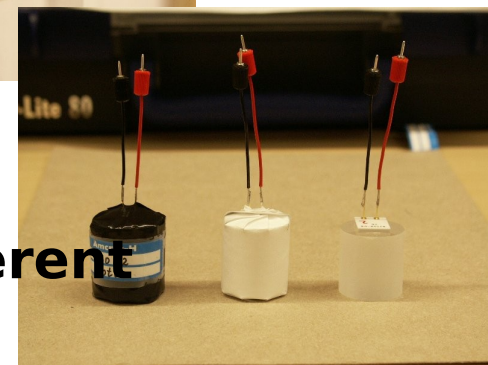
Boule sample from AMCRYS-H



Arrangement of sample crystals for irradiation



PIN-diode mounted on sample

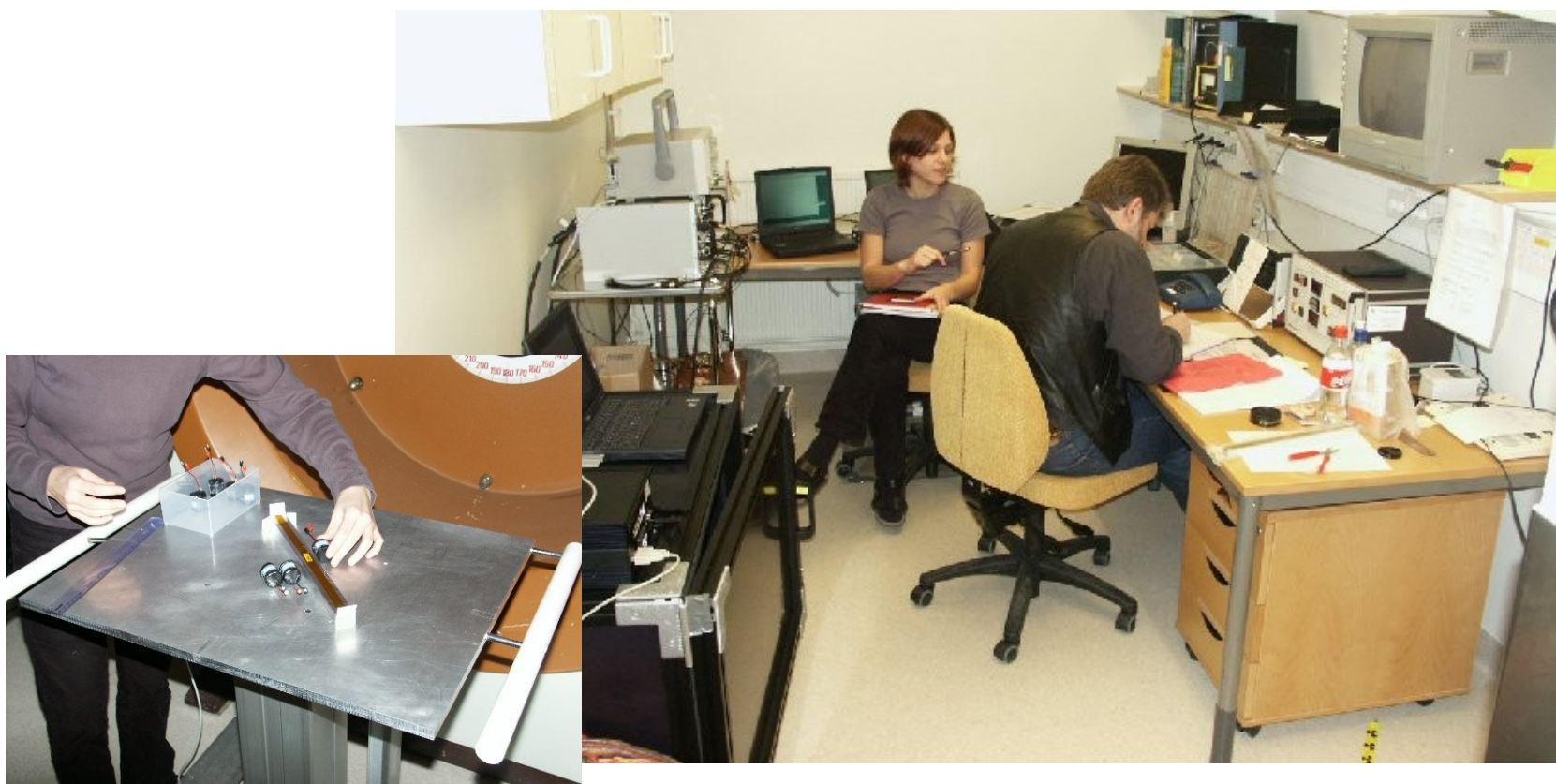


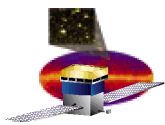
Sample crystals in different stages of preparation



Rad Tests of Boule Samples.

Staffan and Sara working with boule sample testing at the Karolinska Institute in Stockholm

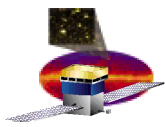




Production Schedule

Basic production schedule (One "delivery unit" (DU) contains 48 crystals)

Month	Week	Boule samples		Crystals (In delivery units, DU)				
		Delivery	Report	Delivery	Unpack	Test	Ship	Number Processed
February	3	1— 4						
	10							
	17							
	24							
March	3	5 — 8	1— 4					
	10							
	17							
	24							
April	7	9 — 12	5 — 8	1, 2	1			
	14				2	1		
	21			3, 4	3	2	1, 2	96
	28				4	3		
May	5	13 — 16	9 — 12	5, 6	5	4	3, 4	192



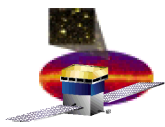
Work Scheme / Staff Plan

- ❑ Each work day divides into 2 shifts, S1 // S3 followed by S2 // S4
- ❑ Two optical test stations operate in parallel
 - S1: optical and mechanical tests of 6 crystals, logging of data
 - S3: analysis and evaluation of test data, filing information on CD, decide on acceptance of individual crystals
 - S2: optical and mechanical tests of 4 crystals, analysis and evaluation of test data, decide on acceptance of individual crystals
 - S4: receiving and sending of crystals, packing/unpacking in V-block and vacuum sealing
- ❑ Once per month: rad tests of boule sample crystals
- ❑ Responsibilities:
 - S1: Tatjana Kirchberg
 - S2,S3: alternatively Georg Johansson and Sara Bergenius
 - S4: Leif Nilsson
 - Rad tests: alternatively Georg Johansson and Sara Bergenius
 - Overall: Staffan Carius



To Do List

- ❑ **Near term items to resolve to automate inspection methods**
 - **Crystal exchange procedure between Kalmar and CEA**
 - **Need to finalize V-block inserts and schedule for delivery from CEA**
 - **Need to finalize data package and data storage**
 - **Proton rad test and accurate correspondence test between boule sample and long crystal**
 - **Coordination of ^{60}Co source at Karolinska Institute. Scheduled boule tests may be postponed up to 2 weeks by hospital radiotherapy users.**



Summary

- ☐ **Test hardware OK**
- ☐ **Test procedures OK**
- ☐ **Production schedule OK**

- ☐ **Expect no further issues, so ready to proceed to flight**